Bandgap formation and multiple scattering in photonic quasicrystals.

A. Della Villa, S. Enoch, G. Tayeb, V. Pierro, V. Galdi, F. Capolino.
Institut Fresnel, CNRS 6133, Université Paul Cézanne Aix-Marseille III, Faculté des Sciences et Techniques, case 161, 13397 Marseille cedex 20, France.
And
Department of Information Engineering, University of Siena, Via Roma 56, 53100 Siena, Italy

We consider a two-dimensional Penrose tiling [1]. In our investigation, we decided to consider a finite number of rods in a homogeneous host medium. The method is based on a multipolar expansion of the fields around (and inside) each cylindrical rod [2,3]. This method has also been recently applied to the study of the local density of states (LDOS) in two-dimensional finite photonic crystals [4].

We show that long-range interactions are involved in the formation of bandgaps with two-dimensional finite-size Penrose-type photonic quasicrystals. The nature of some of the bandgaps can be related, via a simple model, to the Fourier spatial spectrum of the permittivity profile. Unlike these bandgaps, others cannot be explained through simple first-order approximations, indicating that this bandgap stems from multiple scattering processes. To the best of our knowledge, this represents the first example where this phenomenon is shown clearly. The physical mechanisms involved in photonic quasicrystals are quite different from those encountered in connection with photonic crystals, and opportunities of new applications could follow from their full understanding.

[1] M. Senechal, *Quasicrystals and geometry* (Cambridge University Press, Cambridge, 1995)
[2] D. Felbacq, G. Tayeb, and D. Maystre, *J. Opt. Soc. Am. A* **11**, 2526 (1994).
[3] N. Nicorovici et al., *Phys. Rev. E* **52**, 1135 (1995).
[4] A. A. Asatryan et al., *Phys. Rev. E* **63**, 46612 (2001).